Enigmatic Echinoderms of East-Central Missouri

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Introduction by Jo Schaper

Introduction

Ordovician age rocks are well represented in Missouri. They are largely carbonates and thin shales, along with three distinctive sandstone layers: the Gunter at the base of the column, the attractive red and white Roubidoux, used as a building stone, and the St. Peter glass sand. More caves are found in Ordovician rocks than any other, with Cambrian and Mississippian rocks running a close second.

Unlike the Cambrian, Ordovician rocks in Missouri show frequent breaks in deposition. These erosional surfaces indicate that the Ordovician seas were shallower and less constant than those previously. Thickness of some layers varies greatly at different locations; this also shows much environmental variation even over such a small region as Missouri. Four series, (Canadian, Whiterockian, Mohawkian and Cincinnatian) each separated by erosional unconformities exist in the Missouri Ordovician, capped with a large gap between the Ordovician and overlying Mississippian rocks.

No substantial break in deposition occurred between the Cambrian and the Ordovician. In the Ordovician, Missouri had moved slightly north of the paleoequator, but was still well within the tropical zone. The basal Gunter sandstone varies over the region from tens of feet thick to barely recognizable as a sandy layer in the dolomite. The Gasconade dolomite is one of the most massive (and cavernous) units in the sequence, with caves often forming in the youngest Gasconade, near its contact with the Rubidoux formation--usually the aforementioned sandstone. The Gasconade contains stromatolitic chert layers, which often contain well-preserved gastropods and other primitive invertebrate fossils. Subsequent dolomites are thinly bedded, more fossiliferous, and often contain more clay, for a "muddier" or more micritic texture. These rocks of the Lower Ordovician were deposited as the Sauk transgression slowly moved out, leaving the land dry after depositing the Cotter and Powell dolomites.

After a period in which exposed carbonates began to erode, the Tippecanoe transgression began in the Middle Ordovician. The St. Peter sandstone, a very white, friable (it crumbles in your hands), and 98% pure quartz sand is the first Tippecanoe deposit. It forms great cliffs along the eastern side of the state, and has been mined for over 100 years for glass and refractory brick. This rock layer is known as the Crystal Escarpment; excellent exposures are near the towns of Crystal City and Pacific. This "ultra-mature" beach sand marks the second inundation of the Ordovician; immediately above it is the St. Joachim dolomite, whose distinctive yellow "cotton rock" is considered by some to be a primary evaporative dolomite.

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In the Middle Ordovician, minor uplift of the Ozark Dome (southern Missouri) occurred. Ordovician shales deposited at this time are thought to have been derived from as far away as what is now Pennsylvania. Another layer higher in the column worth noting is the Kimmswick formation. This crystalline limestone contains a 6 inch to one-foot thick bentonite band. Bentonite is a swelling clay derived from decomposed volcanic ash. This bentonite layer can be traced through the Midwest, and is thought to be related to the beginning of the Taconic Orogeny--the mountain building episode on the eastern North American coast caused by Africa grinding into the continent, and raising the Appalachian Mountains for the first time about 450 million years ago.

The Late Ordovician in Missouri is represented by a few shales and limestones. The shales were probably formed in shallow environments as the great Ordovician sea retreated, due to mountain building to the east, and a general climatic cooling of the globe, which locked seawater up in Gondwana glaciation at the South Pole.

Ordovician fossils in Missouri are similar to those of the Cambrian, with brachiopods and gastropods dominating, corals becoming more diverse and common, bryozoans and graptolites appearing, trilobites declining and a few interesting additions, such as receptaculids, problematic fossils which resemble the seed heads of the European sunflower. Even though the first land plants appeared in the Ordovician, most, if not all of Missouri was underwater at that time, so there are few fossils of them.

The Kimmswick Formation

The Kimmswick is a Middle Ordovician (Mohawkian series) formation. Its rocks are composed of mostly marine limestone, with its type locality an exposure near the town of Kimmswick in eastern Missouri. It is typically a coarsely crystalline almost marble-like, white to light gray, medium bedded to massive limestone with chert nodules scattered locally in the upper part of the formation. A weathered surface is usually a dull gray or buff color and is distinctively pitted or honeycombed.

The subsurface Kimmswick in north-central and northwestern Missouri is a dolomite as is the surface rock in faulted areas of Perry and St. Genevieve counties. Where the formation is a limestone, it is 95-99% calcium carbonate and is quarried as building stone along a thin belt-line paralleling the Mississippi River from Pike County, south to Scott County. Regionally, it is unconformable on underlying units.

The Kimmswick was first recognized as a distinct lithologic unit in the Ordovician sequence of southeastern Missouri by E. O. Ulrich, who gave it the formal name in 1904, applying it to the crystalline limestone being quarried at Graysboro, Cape Girardeau, Glen Park, Kimmswick and other localities. G. C. Broadhead (Geological Survey of Missouri (1855-1871), p. 49) was, however, the first to recognize the distinctive quality of the rock, but called it the Charette Limestone.

Very few faunal lists have been published for the Kimmswick and these are confusing because some early studies grouped the formation with the underlying Decorah Shale. Rowley provided a list combining the Kimmswick and Plattin in Pike County, Foerste published a list from Ralls County

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and Savage a list from Illinois. Additional study will be required to better differentiate the Kimmswick fauna from underlying strata.

The Kimmswick contains many different marine invertebrate fossils, including, trilobites, brachiopods, bryozoans and early echinoderms, however, well-preserved specimens are more easily collected from shale partings than from the crystalline limestone. A problematic fossil, the "sunflower coral", *Fisherites* (*Receptaculites oweni* Hall, 1861) *reticulatus* (Owen, 1844), S.C. Finney & M. H. Nitecki (1979) is characteristic of the formation and is common in northeastern Missouri. The most interesting and enigmatic fossils of the Kimmswick fauna, however, may be its early echinoderms, which include paracrinoids, cystoids and the elusive crinoid.

The Paracrinoidea

Paracrinoids are members of an extinct class of pelmatozoan echinoderms that lived in warm, shallow seas from the Middle to Late Ordovician period. (470 million to 444 million years ago) They combine features found in other echinoderm groups to create unusual and seemingly un-orderly body plans, even within the same species. All paracrinoids have three 'basal' plates with an attached stem and multiple 'oral' plates that surround and cover the mouth. The remainder of the thecal plates making up the body are placed in an irregular, unpredictable way and most do not display the five-sided symmetry inherent in most echinoderms.

Despite their name, paracrinoids are not closely related to crinoids. Some types, such as *Comarocystites*, actually resemble small, colony corals. *Comarocystites* is the only North American genus with exothecal pinnulate arms.

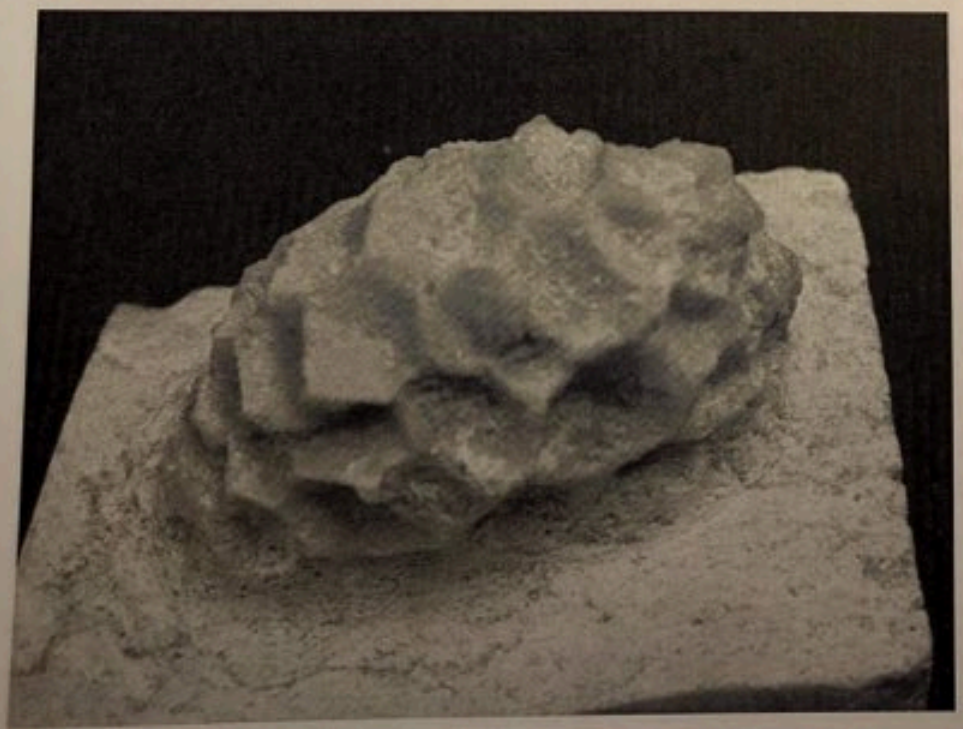

Figure 1. ***Comarocystites shumardi*** Meek & Worthen, 1865, Jefferson County.

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Comarocystites shumardi Meek & Worthen, 1865 (Figure 1) is an extinct, irregular-shaped (ovoid?) paracrinoid of moderate (3.5 cm) size, having two exothecal pinnulate arms and 65-75 irregularly organized, unornamented, deeply concave thecal plates. They are fairly common in the Kimmswick, particularly from Jefferson County south to Cape Girardeau County. Although a loose specimen is occasionally found, most specimens are typically found imbedded in the weathered surfaces of coarse, crystalline rock and are extremely difficult to extract or prepare. The arms and stem are rarely found intact.

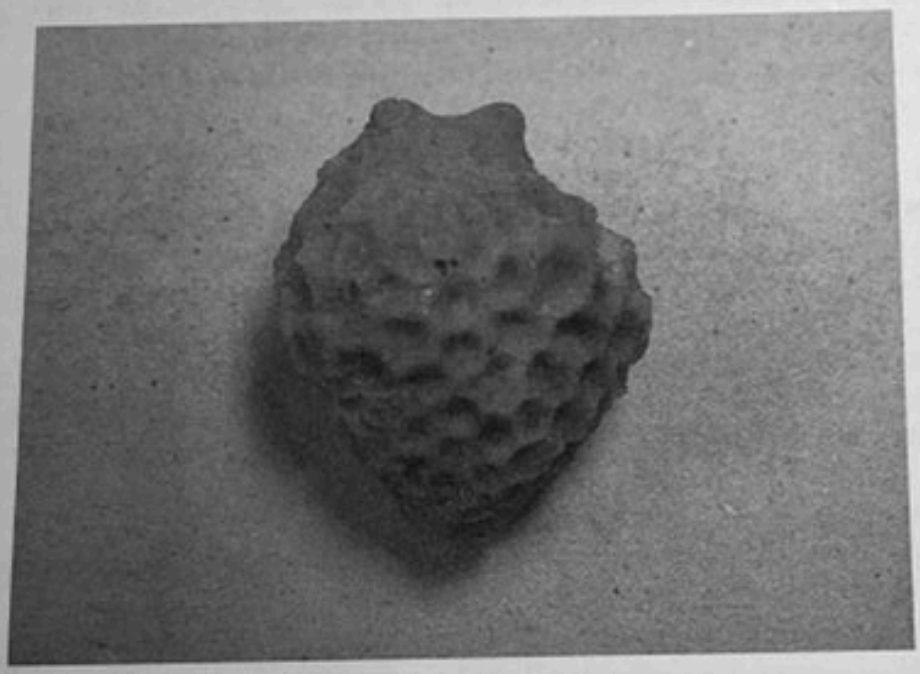

Figure 2. *Comarocystites obconicus* Miller, 1889, Jefferson County.

Comarocystites obconicus Miller, 1889 (Figure 2) is smaller (2.4 cm) than *C. shumardi* and is somewhat cone-shaped. This extinct echinoderm has two exothecal pinnulate arms with 35-40 unornamented concave thecal plates arranged in a more or less orderly echinoderm-like configuration. As with its larger relative, an occasional loose specimen can be collected, but most are found imbedded in weathered surfaces. The arms and stem are rarely found intact.

Wellerocystis kimmswickensis Foerste, 1920 (Figure 3) is a moderate-sized (2.8 cm) extinct ovoid paracrinoid, once thought to be a cystoid. This species has three rays (instead of the customary two) with one primary unbranched ray encircling the anal opening and the other primary ray lying near the oral opening, branching to create the third ray. The unornamented thecal plates are somewhat organized and are convex rather than concave. The size and shape of a stem, if any, is not known from the Kimmswick.

Unidentified paracrinoid (possibly a juvenile *Sinclairocystis* or *Implicatycystis*?) (Figure 4) is a small (1.5 cm) extinct ovoid, paracrinoid that is similar to *Comarocystites*. It differs in that it has very slightly concave thecal plates having holes along their margins which are thought to be respiratory structures. These 'pores' give the illusion of ornamentation. The plates are very similar in

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size and shape. As in *Comarocystites*, this paracrinoid appears to have two exothecal, pinnulate arms, one on each side of the mouth. The arms and stem have not been found intact in the Kimmswick.

Figure 3. ***Wellerocystis kimmswickensis*** Foerste, 1920, Jefferson, County.

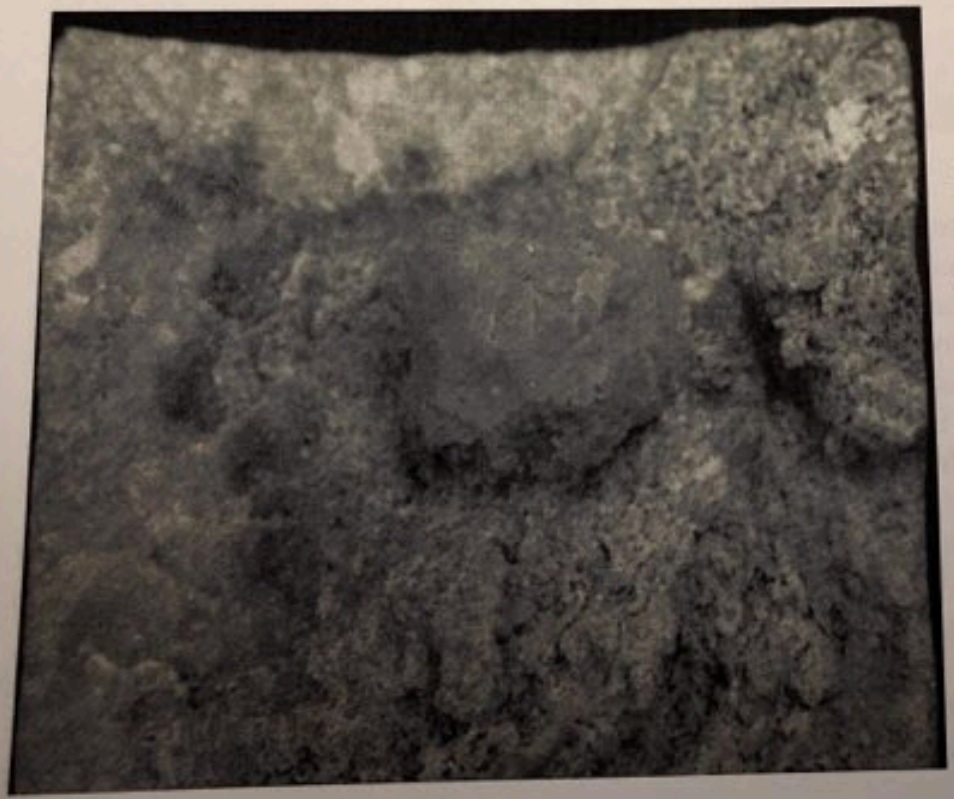

Figure 4. Unidentified paracrinoid *(possibly a juvenile Sinclairocystis* or *Implicatycystis?)*, Perry County.

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The Cystoidea

Cystoids are members of an extinct class of crinozoan echinoderms that lived attached (some by stalk or stem) to solid substrate on the bottom of a warm, shallow sea. They existed from the Middle Ordovician and Silurian periods but went extinct in the Devonian period. They are different from other echinoderms in that they have triangular pore openings which seem to be respiratory in nature. Radiating out from the mouth (at the upper end of the body) were five, or less commonly three, ambulacral areas on the outside of the body. Cystoids resemble crinoids, but are not because they have an ovoid, rather than cup-shaped body.

Figure 5. ***Pleurocystites squamosus*** Billings, 1854, Perry County.

Pleurocystites squamosus Billings, 1854 (Figure 5) is an extinct, moderate-sized (4.5 cm) rhombiferan cystoid that lived in the Middle to Late Ordovician Period. It was attached to the bottom of a warm, shallow sea by means of a short, segmented, crinoid-like stem. The body is supported by an exterior skeleton of unorganized, flat or slightly convex calcitic plates with slight or no ornamentation. At the top of the skeleton, two "feeding tubes" or brachioles extend out from the body, one on either side of the mouth. This cystoid, while rare, is found on weathered surfaces, usually with the stem and "feeding tubes" intact.

Echinosphaerites aurantium Gyllenhaal, 1772 (Figure 6) is an extinct rhombiferan cystoid that lived in the Lower to Middle Ordovician of North America and Europe. It was attached to the marine seafloor by a segmented stem. At the top of the body were six feeding tubes or brachioles, surrounding the mouth. The egg-shaped body was composed of many small plates arranged in a honeycomb-like pattern. The plate-covered anal opening was located on the side of the body. The illustrated specimen was found weathered from the lower Kimmswick at the bottom of a talus slope near Glen Park, Missouri.

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Figure 6. ***Echinosphaerites aurantium*** Gyllenhaal, 1772, Jefferson County.

The Crinoidea

Crinoids are extremely rare in the Kimmswick formation and only *Schizoblastus nodosus* Hall, 1847 is found on any faunal list. This specimen may actually be a throwback to when the Kimmswick formation and the Decorah formation were considered and studied as one unit. That being said, a single calyx of *Porocrinus* has been found by this author in strata near the type locality at Kimmswick, Missouri.

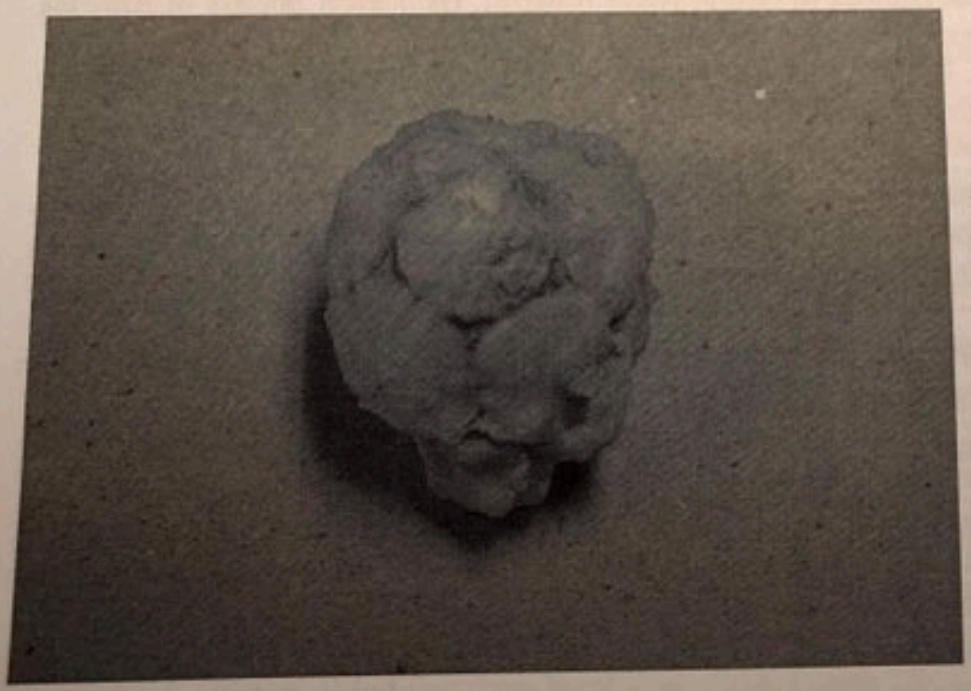

Figure 7. ***Porocrinus*** *(conicus?)* Billings, 1857, Jefferson County.

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Porocrinus (conicus?) Billings, 1857 (Figure 7) is a small extinct cladid crinoid possessing characteristics of crinoids, blastoids and cystoids. It demonstrates five-fold symmetry with an organized cone-shaped calyx and a conical cup composed of five infrabasal plates. The surface of its basal and radial plates has radiating ribs extending from the center. These plates have pectinated openings, a characteristic of cystoids, however, the openings are at the corner junctions between plates instead of along the sides as in the case of cystoids.

At the top of the calyx are five equally spaced spiracle-like holes with a probable mouth at their center, similar to the structures seen in blastoids. Unlike most crinoids, it is difficult to determine the location of articulating surfaces for arms.

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